Acta Odontologica Scandinavica, 2012; 70: 564–568

informa
healthcare

ORIGINAL ARTICLE

Methods used for prevention of white spot lesion development during orthodontic treatment with fixed appliances

ANTOINE E. G. KERBUSCH[1], ANNE M. KUIJPERS-JAGTMAN[1], JAN MULDER[2] & WIL J. M. VAN DER SANDEN[3]

[1]*Department of Orthodontics and Craniofacial Biology,* [2]*Department of Methodology, Information Management and Statistics, Nijmegen, The Netherlands, and* [3]*Department of Global Oral Health, Radboud University Nijmegen Medical Centre, Nijmegen, The Netherlands*

Abstract

Objectives: The aim of this study was to survey methods that Dutch orthodontists use to prevent development or progression of enamel decalcifications during orthodontic treatment. ***Materials and methods:*** A pre-tested questionnaire was sent by post to all orthodontists in the Netherlands with a private practice ($n = 189$). ***Results:*** The response rate was 81%. At the start of orthodontic treatment a basic practice protocol for prevention of enamel demineralization was used by 93% of the orthodontists. This included oral hygiene instructions (92%) and the advice for additional use of a fluoride mouth rinse (64%). Other preventive measures were rarely prescribed. About 85% of those who prescribed a fluoride mouth rinse advised to rinse once a day, directly after evening tooth brushing. ***Conclusions:*** The results suggest that the commonly used practice of fluoride mouth rinsing directly after evening tooth brushing by orthodontic patients during fixed appliance treatment ignores actual evidence of preventive advices. This study recommends mouth rinsing at another moment than after evening tooth brushing, thus increasing the frequency of fluoride intakes, which might enhance the effectiveness in preventing WSL development or progression during orthodontic treatment.

Key Words: *evidence-based practice, demineralization, fluoride, orthodontics, white spot lesions*

Introduction

Orthodontic treatment with fixed appliances is associated with an increased risk of enamel demineralization, mainly seen as white spot lesions (WSL, Figure 1). The incidence of new enamel lesions in orthodontic patients treated with fixed appliances and using fluoride toothpaste has been reported to be 13–75% [1,2]. Other studies reported a prevalence of 50% [3–9]. Enamel demineralization during orthodontic treatment appears most frequently on the cervical and middle third of the buccal surfaces of maxillary lateral incisors, the mandibular canines and first premolars [2,10,11]. WSL are not only a problem during orthodontic treatment, but also afterwards. After all, permanent enamel damage will be visible, which can lead to an esthetic problem or even to further caries progression [10–13].

It is generally accepted that placement of fixed orthodontic appliances (e.g. brackets, bands and wires) creates retention areas for dental plaque, because of their irregular surfaces [14–16]. *Mutans streptococci* play an important role in the development of demineralization and dental caries [11]. Amongst others, factors associated with higher risk of WSLs are younger age at start of treatment, longer treatment duration, percentage of treatment time in elastomeric chain, number of missed appointments, number of poor hygiene citations in the patient chart, poor compliance, male gender and fair or poor oral hygiene at the screening examination [17].

There are no specific clinical guidelines available for caries preventive measures during orthodontic treatment. Patient education and fluoride administration, e.g. sodium fluoride containing mouth rinses, are generally accepted methods to prevent the

Correspondence: Anne Marie Kuijpers-Jagtman, Department of Orthodontics and Craniofacial Biology, Radboud University Nijmegen Medical Centre, 309 Dentistry, PO Box 9101, 6500 HB Nijmegen, The Netherlands. Tel: +31(0)24 3614005. Fax: +31(0)24 3540631. E-mail: orthodontics@dent.umcn.nl

(Received 4 May 2011; revised 13 July 2011; accepted 16 August 2011)

ISSN 0001-6357 print/ISSN 1502-3850 online
DOI: 10.3109/00016357.2011.640282

Figure 1. White spot lesions after 14 months of orthodontic treatment with fixed appliances.

formation of WSL [18]. The aim of this study was 2-fold: (a) to gain insight into the preventive measures applied as a standard procedure in orthodontic practices in the Netherlands and (b) to relate these measures to available evidence-based information.

Materials and methods

Participants

The study group consisted of all registered orthodontists in the Netherlands, listed in the Dutch orthodontic specialist register. Inclusion criteria were: working in an orthodontic private practice in the Netherlands, known phone number, mail- and postal address. If one of these data was missing, the participant was excluded.

Survey

The questionnaire had three parts. The first part comprised items on personal and practice background characteristics. In the second part the presence of a basic practice protocol for prevention of WSLs was surveyed, as well as the concentration and frequency of a fluoride mouth rinse, if recommended, to prevent WSL at the start of and during orthodontic treatment. The last part contained items on the orthodontists' individual opinion and perception of the expected patient compliance and motivation to follow preventive measures instructions. In addition, if prescribed, participants were asked to send in an (anonymous) example of their prescription for fluoride mouth rinse, together with the completed questionnaire.

The questionnaire was pilot tested on three faculty orthodontists and was subsequently modified.

Procedure

The questionnaire, accompanied by a cover letter, explaining the purpose and the study design, was sent by post to all 189 orthodontists in the Netherlands, who fulfilled the inclusion criteria. A pre-paid reply envelope was enclosed that was confidentially coded in order to have the option to send a reminder to the non-responders. One month later, non-responders received a reminder by e-mail with an attached questionnaire. They could respond by e-mail or by post. A second reminder was mailed to the non-responders 1 month after the first reminder. A non-response survey was planned if the response rate would be less than 75%. This would consist of a phone call with structured questions asking for the reason for not responding.

The returned questionnaires were numbered, processed anonymously and stored in a separate file and could not be traced to the reply envelope. In case a prescription was included with the completed questionnaire, the respondents' data were removed and the same number was linked to the prescription and respondent. If the orthodontist responded by e-mail, data was processed the same way.

Statistical analysis

The data was processed for statistical analysis using SAS software, version 9 (SAS Institute Inc., Cary, NC). The information was described in percentages. All tests for the relationship between the items in the questionnaire were based on the Chi-square test. Participants were clustered into two groups concerning their institute of orthodontic education, i.e. Dutch university, or abroad.

Furthermore, for both groups, year of orthodontic graduation was clustered into another three groups, i.e. 1971–1984; 1985–1993; and 1994–2007, respectively. Differences between the year and university of graduation and the questions about the prescription of fluoride mouth rinse were tested with a Chi-square test. The significance level was set at $p < 0.05$.

Results

Participants

Eventually, after two reminders, the questionnaire was returned by 154 (81%) of the 189 included orthodontists. A non-response survey was not performed. A fluoride prescription was added by 102 (66%) respondents.

On average, orthodontists had almost 20 years of practice experience (range year of graduation from 1971–2007). Eighty-one per cent of the orthodontists had received their orthodontic education in the Netherlands and 19% abroad. A small majority (58%) work in solo private practice, 23% in group practice and 19% had another working setting.

Practice protocol

On the question 'Do you use a basic caries preventive protocol in your practice, comprising preventive advices on oral hygiene and prevention of enamel demineralization, before or during treatment with fixed appliances?', 93% of the respondents answered 'yes', 4% only used a practice protocol when WSL appeared and 3% did not have practice protocol.

In the basic practice protocol (Table I), oral hygiene instruction (92%) and prescription of fluoride mouth rinse (64%) were mostly used. Other preventive measures (e.g. fluoride tablets, high fluoride toothpaste, chlorhexidine varnish) were rarely prescribed. No difference between year of graduation and prescribing a fluoride mouth rinse was found (Chi Square Test, $p = 0.1$). Between orthodontists who had their education abroad or at a Dutch university no statistical difference was found in prescribing fluoride rinse as a standard procedure ($p = 0.91$) in the frequency ($p = 0.13$) and the concentration of the fluoride mouth rinse ($p = 0.68$). Sixty-four per cent of the orthodontists prescribed fluoride mouth rinsing as a routine procedure, 15% only prescribed when WSLs were clinically visible, 9% never prescribed a fluoride mouth rinse and 9% prescribed for other reasons.

Table II shows the different concentrations of fluoride mouth rinse prescribed. The concentrations of fluoride mouth rinse on the prescriptions were all in accordance with the answers in the questionnaire. Most orthodontists (90%) that prescribed fluoride mouth rinse advised to rinse once a day, whereas 7% advised to rinse twice a day. Mostly, it was recommended to rinse directly after evening tooth brushing, some (5%) advised to rinse in between. Those who advised to rinse twice a day also advised to rinse after tooth brushing.

Compliance of the patient

Sixty-three per cent of the orthodontists answered that their patients with fixed appliances often have insufficient or poor oral hygiene. On the question 'will the oral hygiene improve after a repeated oral hygiene instruction', 42% of the orthodontists think that the oral hygiene will improve, whereas 58% of the orthodontists think that there will be little or no improvement.

When asked 'how often do your patients use the prescribed mouth rinse, according to your advice?', 53% indicated that they thought that patients actually used it according to the prescription and almost 33% said that the advice was followed only occasionally.

Discussion

The aims of this study were gaining insight into WSL preventive measures applied in orthodontic practices and to relate these measures to internationally accepted evidence-based recommendations.

The majority of respondents used a basic practice protocol for prevention of WSL at the start of treatment. Before commencing orthodontic treatment patients should have adequate oral hygiene, otherwise individual oral hygiene instruction will be given until this level has been reached.

Sixty-four per cent prescribed a fluoride mouth rinse, but just over half of them thought that patients used the mouth rinse actually as prescribed. This is well in accordance with results from previous studies showing that only half of the patients used fluoride mouth rinse as prescribed [18,19]. It is remarkable that no further preventive actions were mentioned, although it was recognized that patients did not follow preventive advices. In addition, a recent survey reported that over 60% of orthodontists in the Netherlands think that patients' oral hygiene deteriorates during orthodontic treatment [20]. Referral to a dental hygienist for oral hygiene instruction, combined with a recurrent motivational interviewing technique [21], might increase patients' oral health awareness and could eventually lead to a reduction of WSLs.

Almost all orthodontists who advised to rinse with sodium fluoride prescribed their patient to do so only at night after brushing. There is some evidence that

Table I. Frequencies (percentage of orthodontists) for WSL prevention measures that were part of the prevention protocol at the start of orthodontic treatment with fixed appliance.

Protocol at the start of the treatment	Always (%)	Usually (%)	Sometimes (%)	Never (%)
Oral hygiene instruction	92	6	1	1
Fluoride mouth rinse	64	11	19	6
Fluoride application (gel)	5	4	29	62
High fluoride concentration toothpaste (>1500 ppm)	5	2	22	71
Fluoride tablets	2	1	12	85
Chlorhexidine mouth wash	1	4	70	25
Chlorhexidine varnish application	0	2	36	62
Other	0	0	0	0

Table II. Frequencies (percentage of orthodontists) who prescribed a specific concentration of sodium fluoride mouth rinse.

Concentration sodium fluoride mouth rinse	Orthodontists (%)
0.025%	17
0.05%	65
0.1%	9
Other	9

regular rinsing with a fluoride mouth rinse is effective in reducing the severity of white spots during orthodontic treatment. Geiger et al. [19] showed that additional use of fluoride mouth rinse resulted in a 25% reduction in the incidence of teeth affected by WSL. When combining mouth rinsing with other fluoride therapies such as toothpaste, it is prudent to spread the fluoride intake over different times of the day to maximize the overall efficacy [17]. Newbrun [22] found that a higher concentration and frequency of fluoride use showed a greater caries reduction effect.

A change of the orthodontists' advice, to rinsing at a time other than directly after tooth brushing, would lead to more fluoride intake and thus a possible decrease in the prevalence of WSL. Rinsing directly after coming home from school, e.g., will lead to additional fluoride exposure, without any increase of healthcare costs. Moreover, patients might accept rinsing more than additional tooth brushing. Eventually, this might even lead to a reduction of oral healthcare costs, as it might decrease development or progression frequencies of WSL.

Respondents prescribed or applied hardly any other preventive measures than fluoride mouth rinse during orthodontic treatment with fixed appliances. The different modes of application of topical fluoride, i.e. toothpaste, mouth rinses, gels and varnishes, have been tested in different patients treated with non-removable orthodontic appliances. No consensus exists about which method or combination of methods is most effective in prevention of WSL during orthodontic treatment. The caries protective effect of high concentration (36 000 ppm) fluoride varnishes has been widely acknowledged during orthodontic treatment [5,23]. However, only 9% of the orthodontists in the present study applied it regularly (Table II). There is no obvious reason why most orthodontists did not do so. It may be possible that the orthodontists were not aware of the preventive potential of fluoride varnish.

A completely different approach to avoid buccal WSL after treatment could be the use of lingual fixed appliances. Eventually, WSL around brackets will not be visible using the lingual bracket technique. It was found that the frequency of WSL that developed or progressed on buccal surfaces was 4.8-times higher than on lingual surfaces [24]. This may be explained by differences in surface morphology, plaque retention, salivary flow and mechanical cleaning of surfaces by the tongue. This is a promising result and needs further attention.

This study showed that orthodontists did yet not implement available evidence to prevent enamel demineralization during fixed appliance treatment in their clinical practice. This is consistent with findings of an earlier study [20]. It is well known that transfer and implementation of results from research into daily practice is difficult [25,26]. Several explanations exist, e.g. personal and practice characteristics, issues like the health insurance package, but also patients' preferences and expectations play an important role. It needs further investigation to detect possible barriers in this field.

Although fluoride products during orthodontic treatment are widely prescribed, there is little evidence which method or combination of methods to deliver fluoride is most effective [27–29]. Further research is needed into different modes of delivery. Furthermore we recommend to develop clinical practice guidelines, comprising all scientific and clinical evidence, for the prevention of enamel demineralization at the start of (and during) orthodontic treatment.

Conclusion

The commonly used practice of fluoride mouth rinsing directly after tooth brushing by orthodontic patients during fixed appliance ignores actual preventive advice. We recommend mouth rinsing at another moment than after tooth brushing, thus increasing the frequency of fluoride intake, which might enhance the effectiveness in preventing WSL development or progression during orthodontic treatment.

***Declaration of interest*:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Fornell AC, Sköld-Larsson K, Hallgren A, Bergstrand F, Twetman S. Effect of a hydrophobic tooth coating on gingival health, mutans streptococci, and enamel demineralization in adolescents with fixed orthodontic appliances. Acta Odont Scand 2002;60:37–41.

[2] Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. Am J Orthod 1982;81: 93–8.

[3] Benson PE, Shah AA, Millett DT, Dyer F, Parkin N, Vine RS. Fluorides, orthodontics and demineralization: a systematic review. J Orthod 2005;32:102–14.

[4] Derks A, Katsaros C, Frencken JE, van't Hof MA, Kuijpers-Jagtman AM. Caries-inhibiting effect of preventive measures during orthodontic treatment with fixed appliances. A systematic review. Caries Res 2004;38:413–20.

[5] Farhadian N, Miresmaeili A, Eslami B, Mehrabi A. Effect of fluoride varnish on enamel demineralization around brackets: an in-vivo study. Am J Orthod Dentofacial Orthop 2008;133: 95–8.
[6] Lovrov S, Hertrich K, Hirschfelder U. Enamel demineralization during fixed orthodontic treatment – Incidence and correlation to various oral-hygiene parameters. J Orofac Orthop 2007;68:353–63.
[7] Stecksén-Blicks C, Renfors G, Oscarson ND, Bergstrand F, Twetman S. Caries-preventive effectiveness of a fluoride varnish: a randomized controlled trial in adolescents with fixed orthodontic appliances. Caries Res 2007;41:455–9.
[8] Sudjalim TR, Woods MG, Manton DJ. Prevention of white spot lesions in orthodontic practice: a contemporary review. Aust Dent J 2006;51:284–9.
[9] Zimmer BW, Rottwinkel Y. Assessing patient-specific decalcification risk in fixed orthodontic treatment and its impact on prophylactic procedures. Am J Orthod Dentofacial Orthop 2004;126:318–24.
[10] Årtun J, Brobakken BO. Prevalence of carious white spots after orthodontic treatment with multibonded appliances. Eur J Orthod 1986;8:229–34.
[11] Øgaard B. Prevalence of white spot lesions in 19-years-olds; a study on untreated and orthodontically treated persons 5 years after treatment. Am J Orthod Dentofacial Orthop 1989;96: 423–7.
[12] O'Reilly MM, Featherstone JDB. Decalcification and remineralization around orthodontic appliances: an in vivo study. Am J Orthod Dentofacial Orthop 1987;92:33–40.
[13] Shungin D, Olsson AI, Persson M Orthodontic treatment-related white spot lesions: a 14-year prospective quantitative follow-up, including bonding material assessment. Am J Orthod Dentofacial Orthop 2010;138:136.e1–8.
[14] Batoni G, Pardini M, Giannotti A, Ota F, Guica MR, Gabrielle M, et al. Effect of removable orthodontic appliances on oral colonisation by mutans streptococci in children. Eur J Oral Sci 2001;109:388–92.
[15] Petti S, Barbato E, Simonetti d'Arca A. Effect of orthodontic therapy with fixed and removable appliances on oral microbiota: a six-month longitudinal study. New Microbiol 1997; 20:55–62.
[16] Rosenbloom RG, Tinanoff N. Salivary streptococcus mutans levels in patients before, during, and after orthodontic treatment. Am J Orthod Dentofacial Orthop 1991;100: 35–7.
[17] Chapman JA, Roberts WE, Eckert GJ, Kula KS, González-Cabezas C. Risk factors for incidence and severity of white spot lesions during treatment with fixed orthodontic appliances. Am J Orthod Dentofacial Orthop 2010;138:188–94.
[18] Geiger AM, Gorelick L, Gwinnett AJ, Griswold PG. The effect of a fluoride program on white spot formation during orthodontic treatment. Am J Orthod Dentofacial Orthop 1988;93:29–37.
[19] Geiger AM, Gorelick L, Gwinnett AJ, Benson BJ. Reducing white spot lesions in orthodontic populations with fluoride rinsing. Am J Orthod Dentofacial Orthop 1992;101:403–7.
[20] Derks A, Kuijpers-Jagtman AM, Frencken JE, Van't Hof MA, Katsaros C. Caries preventive measures used in orthodontic practices: an evidence-based decision? Am J Orthod Dentofacial Orthop 2007;132:165–70.
[21] Miller NH. Motivational interviewing as a prelude to coaching in healthcare settings. J Cardiovasc Nurs 2010;25:247–51.
[22] Newbrun E. Topical fluorides in caries prevention and management: a North American perspective. J Dent Educ 2001; 65:1078–83.
[23] Shafi I. Fluoride varnish reduces white spot lesions during orthodontic treatment. Evid Based Dent 2008;9:81–4.
[24] Van der Veen MH, Attin R, Schwestka-Polly R, Wiehcmann D. Caries outcomes after orthodontic treatment with fixed appliances: do lingual brackets make a difference? Eur J Oral Sci 2010;118:298–303.
[25] Grol RP, Bosch MC, Hulscher MEJL, Eccles MP, Wensing M. Planning and studying improvement in patient care: the use of theoretical perspectives. The Milbank Quarterly 2007;85:93–138.
[26] Sanden WJM van der, Mettes DG, Plasschaert AJM, Grol RT, Hof MA van 't, Knutsson K, et al. Effect of selected literature on dentists decisions to remove asymptomatic, impacted lower third molars. Eur J Oral Sci 2002;110:2–7.
[27] Blinkhorn AS, Holloway PJ, Davies TG. Combined effects of a fluoride dentifrice and mouth rinse on the incidence of dental caries. Community Dent Oral Epidemiol 1983;11: 7–11.
[28] Derks A, Frencken J, Bronkhorst E, Kuijpers-Jagtman AM, Katsaros C. Effect of chlorhexidine varnish application on mutans streptococci counts in orthodontic patients. Am J Orthod Dentofacial Orthop 2008;133:435–9.
[29] Nyvad B. Microbial colonization of human tooth surfaces. Acta Pathol Microbiol Immunol Scand 1993;101(Suppl 32): 1–45.